A Key to the Late Instar Larvae of Some Hawaiian Noctuidae[1]

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The family Noctuidae (=Phalaenidae of some authors) is a large and economically important group of Lepidoptera. The Hawaiian noctuid fauna contains both endemic and recently adventive elements. Zimmerman (1958) listed 88 described species for Hawaii, but the subsequent discovery of several additional immigrants plus the known existence of a number of undescribed endemic forms, raises the total number of species to well over one hundred.

With a few exceptions, it is the larval stages of Noctuidae which cause damage to crop and ornamental plants, yet the larvae of the Hawaiian species are still poorly known. Identification of larvae has been difficult or impossible without reference to adequate collections of properly preserved and identified specimens, and few such collections of Hawaiian species exist. Swezey (1944) presented a key to some common larval Lepidoptera found in Hawaiian gardens, and the noctuid portion of this was revised slightly by Zimmerman (1958). Swezey (1909) also described and illustrated larvae of several Hawaiian armyworms and cutworms. Because a number of additional immigrant species have become established during the past several decades these works are out of date.

The present key is based upon specimens preserved in alcohol which are in the collection of the Department of Entomology, University of Hawaii. Thirty-nine species are treated. All of the more common and many of the less common immigrant species are included. Of the known immigrant species only *Leucania loreyi* (Duponchel), *Leucania striata* Leech, *Prospalta dolorosa* (Walker), and *Trichoclea postica* Smith were not available as larvae. Usable larvae of only four of the more common endemic noctuids were available for study; *Agrotis dislocata* (Walker), *A. crinigera* (Butler), *Anomis hawaiiensis* (Butler), and *Heliothis hawaiiensis* (Quaintance and Brues). Larvae of most of the endemic species are still either unknown, or were represented by specimens which were unsatisfactory for detailed study. A more complete treatment of the endemic Hawaiian noctuid larvae will not be possible until adequate collections, based on extensive field work and careful laboratory rearing, have been made. However, as most of the endemic species are restricted to areas of native vegetation, largely in the mountains, the present key should accommodate nearly all the forms encountered in lowland urban and agricultural environments.

Specimens utilized in the preparation of the key were three-quarters to fully grown. Although the key is believed to be adequate for larvae in the later instars of development, it is not intended for use with very small (first, second and third

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instar) caterpillars. However, it is generally the later instar larvae which are presented for identification. As the key is based upon specimens in alcohol, emphasis has been placed on structural characters rather than on color patterns of living larvae, as colors frequently fade and patterns may be largely obliterated with time. Dark areas of sclerotized structures such as the head capsule and suranal plate tend to be more permanent and these have been utilized to a limited extent in the key. For general discussions on morphology of lepidopterous larvae, see Peterson (1962) and Zimmerman (1979). The comprehensive work on North American noctuid larvae by Crumb (1956) was also utilized in preparing the following key. The principal morphological characters used in the key are illustrated in figure 1. I have attempted to utilize structures which are readily visible wherever possible. However, considerable use has been made of the structure of the mandibles, and frequently it may be necessary to pry the mandibles apart in order to observe characters of the inner face and apical dentition.

The included figures are intended to illustrate important characters used in the key, and no attempt was made to make them complete in every detail. In many cases they are little more than sketches made with the aid of a dissecting microscope.

DEFINITIONS OF TERMS

To facilitate the use of the key, definitions are given here of some of the terms employed which may not be familiar to all users.

On the head, the *adfrontal sclerites* are the two relatively long narrow sclerites which occur, one on either side of the frons, in virtually all lepidopterous larvae. The *coronal suture* refers to that portion of the inverted "Y"-shaped epicranical suture which forms the stem of the "Y" extending from the apex of the frons to the occipital margin of the head capsule. On the mandibles, a *retinaculum* is a specialized cutting or grinding structure on the inner face of the mandible, below and separate from the marginal dentition. The *ventral prolegs* are the fleshy, non-segmented legs of abdominal segments 3, 4, 5 and 6 in lepidopterous larvae. They do not include the prolegs of tenth abdominal segment, which are known as *anal prolegs. Crochets* are the small hook-like grasping structures which, in Noctuidae, are arranged in a compact line or arc on the outer end of the prolegs.

On the general integument, a *seta* is a flexible, hairlike cuticular process the base of which is set in a flexible membrane (articular membrane) which is enclosed by a narrow sclerotized ring. Frequently the hair-bearing structure protrudes slightly from the general body surface and is termed a *papilla. Spines, microspines* and *spinules* are small cuticular processes which differ from setae in that their bases are not set in ring-bounded membranes. [Setae are in fact the terminal organs of trichoid sensilla, which function as mechanoreceptors in insects.] A *pinaculum* is a small, flat or slightly elevated sclerotized plate which surrounds usually one, but sometimes several setae. A small sclerotized conical tubercle bearing an apical seta is known as a *chalaza.*

The system employed here to designate setae of the head and body segments is illustrated in figure 1.

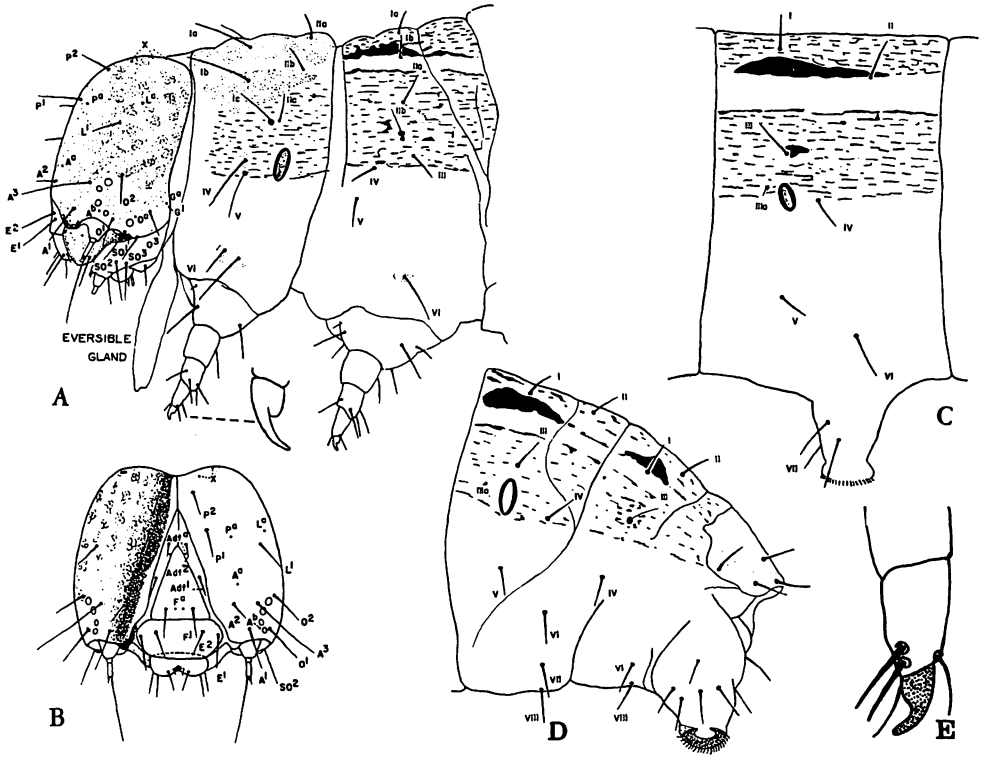

FIGURE 1. *Spodoptera mauritia,* mature larva. A, lateral aspect of head, prothorax and mesothorax; B, frontal aspect of head; C, lateral aspect of fourth abdominal segment; D, lateral aspect of abdominal segments 8-10; E, inner face of foretarsus. (modified from Tanada and Beardsley, 1958)

KEY TO LATE INSTAR LARVAE OF SOME HAWAIIAN NOCTUIDAE

1. Three or four pairs of normal ventral prolegs[3] (i.e.: with well-developed crochets) present, anterior pairs sometimes reduced in size 6
   Ventral prolegs restricted to abdominal segments 5 and 6 (2 pairs, except minute vestiges sometimes present on segments 3 and 4) 2
2. Crochets of prolegs biordinal (alternating short and long (fig. 2A)); size average, length of full-grown larva 30 to 40 mm. 3
   Crochets of prolegs uniordinal (not of alternating lengths); size smaller, length of full-grown larva 25 mm or less 5
3. Integument beset with microspines (fig. 2D); vestigial prolegs absent on abdominal segments 3 and 4 . . . . . *Plusia (Autographa) biloba* (Stephens)
   Integument without microspines; vestigial prolegs present on abdominal segments 3 and 4 (fig. 2E) 4
4. Ridges on inner face of mandible extending to outer margin, not enlarged to form submarginal teeth (fig. 2B). . . . . *Trichoplusia ni* (Hübner)
   Second and third ridges on inner face of mandible enlarged to form small submarginal teeth (fig. 2C). . . . . *Chrysodeixis chalcites* (Esper)
5. Body setae pale, without dark basal rings; height of eighth abdominal spiracle less than twice (8:5) that of seventh; in flowers of *Waltheria americana* . . . . . *Eublemma anachoresis* (Wallengren)
   Body setae dark with bases surrounded by narrow black rings (fig. 2G); eighth abdominal spiracle more than twice (12:5) as high as seventh; in flowers of *Sida, Abutilon,* etc.. . . . . *Amyna natalis* (Walker)
6. Skin of body densely beset with minute slender spines or pointed spinules (figs. 2F, 2I) 7
   Skin not beset with microspines or spinules 10
7. Crochets entirely uniordinal; derm beset with minute spinules (fig. 2F); setae on inner face of tarsi near claw spatulate (fig. 2H) . . . . . *Simplicia lautokiensis* Prout
   Crochets biordinal, at least at center of row; derm beset with distinct microspines plus minute granulation in dark areas (fig. 2I); setae on inner face of tarsi not spatulate *(Heliothis)* 8
8. Setae I and II of abdominal segments, particularly segments 1, 2, and 8, borne on distinct conical tubercles (chalazae) (figs. 2J, 2K) 9
   Setae I and II of abdominal segments not on distinct chalazae . . . . . *Heliothis hawaiiensis* (Quaintance & Brues)
9. Inner face of mandible with a prominent, mesal, truncate tooth (retinaculum) (fig. 3A); microspines present on chalazae I and II of abdominal segments 1, 2, and 8 (fig. 2J) . . . *Heliothis virescens* (Fabricius)
   Inner face of mandible without a mesal retinaculum: microspines absent on chalazae I and II of abdominal segments (fig. 2K) . . . . . *Heliothis zea* (Boddie)

[3]The user is cautioned to remember that the term "ventral prolegs" applies only to prolegs of abdominal segments 3, 4, 5, and 6. The prolegs of the tenth abdominal segment are known as "anal prolegs".

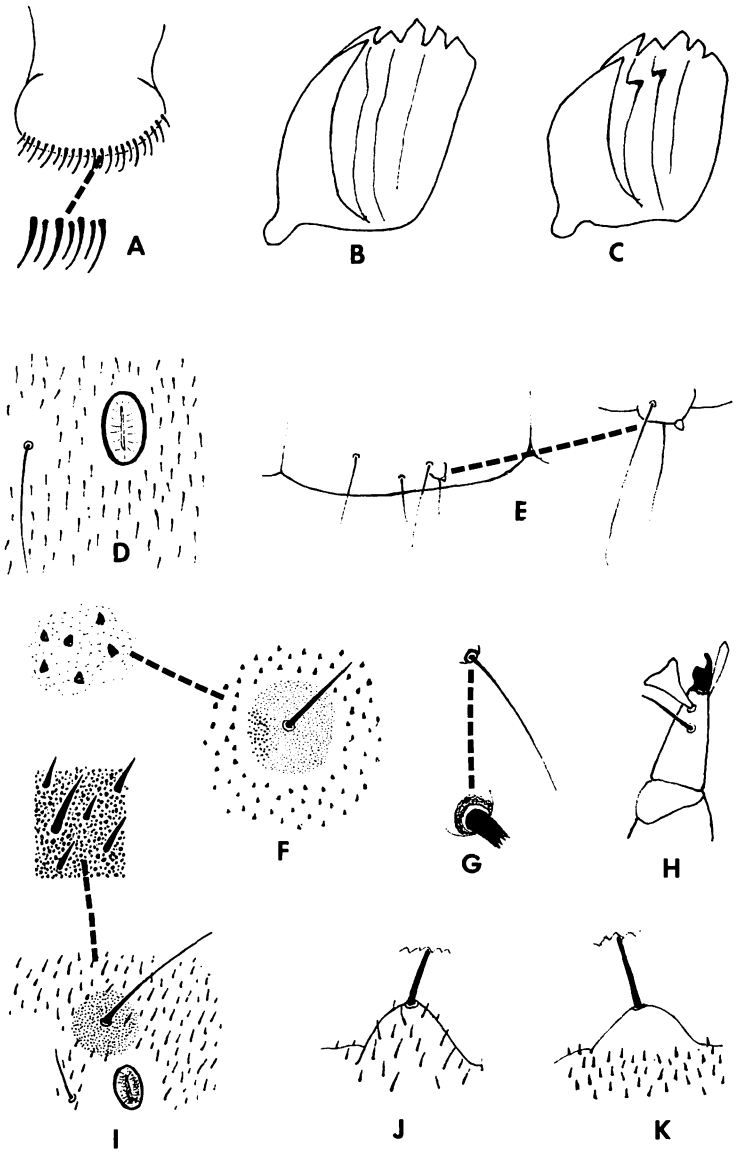

FIGURE 2. A, *Chrysodeixis chalcites,* ventral proleg to show biordinal crochets; B, *Trichoplusia ni,* inner face of right mandible; C, *Chrysodeixis chalcites,* inner face of right mandible; D, *Plusia biloba,* eighth abdominal spiracle and surrounding derm to show microspines; E, *Chrysodeixis chalcites,* ventral margin of fourth abdominal segment to show vestigial proleg; F, *Simplicia lautokiensis,* mesothoracic pinaculum and surrounding derm to show micro-spinules; G, *Amyna natalis,* body seta to show dark ring around setal base; H, *Simplicia lautokiensis,* inner face of front tarsus to show spatulate seta; I, *Heliothis virescens,* portion of seventh abdominal segment to show setal pinaculum III and surrounding dermal microspines and granulation; J, *Heliothis virescens,* chalaza of seta I, abdominal segment 8 (distal portion of seta not shown); K, *Heliothis zea,* chalaza of seta I, abdominal segment 8.

10. Seta II on each side of eighth abdominal segment borne on a large conical protuberance (gibbosity) (fig. 3C); ninth abdominal segment without such protuberances 11
Seta II of eighth abdominal segment not borne on a conspicuously enlarged protuberance or if on a slightly enlarged protuberance, then this not noticeably larger than corresponding protuberance of ninth segment 13
11. Crochets of prolegs biordinal; body mostly grayish; on lantana . . . . . *Neogalea esula* (Druce)
Crochets uniordinal; body with longitudinal reddish-brown bands. 12
12. Head capsule with a large lateral white spot and several smaller white spots on each side (fig. 3E)[4]; dorsum with a distinct transverse black marking intersegmentally between abdominal segments 1 and 2; usually on Euphorbiaceae . . . . . *Achaea janata* (L.)
Head capsule with several longitudinal dark bands; sometimes interrupted, on each side (fig. 3D); dorsum without such an intersegmental black mark; on Myrtaceae . . . . . *Anua indiscriminata* (Hampson)
13. With 3 pairs of ventral prolegs (prolegs on abdominal segment 3 absent) 14
With 4 pairs of ventral prolegs, those of abdominal segment 3 sometimes reduced 17
14. Crochet row of first pair of prolegs oriented diagonally or transversely; dorsum with pale longitudinal stripes; on *Delonix regia* (flame tree) . . . . . *Pericyma cruegeri* (Butler)
Crochet row of first pair of prolegs oriented longitudinally; not so marked 15
15. Crochets of prolegs without a subapical tooth; body setae elongate (eg: II on abdominal segments 8 and 9 about twice as long as segment on which it occurs); on lantana. . . . . *Hypena strigata* (Fabricius)
Crochets of prolegs with a subapical tooth (fig. 3B); setae shorter (II on abdominal segments 8 and 9 about as long as segment bearing it); on Malvaceae. 16
16. Bases of setae, particularly on dorsum, surrounded by a narrow black ring; setigerous tubercles weakly developed, unpigmented . . . . . *Anomis flavus* (Fabricius)
Bases of setae not surrounded by a narrow black ring; setae borne on well defined, usually dark brown tubercles . . . . . *Anomis hawaiiensis* (Butler)
17. Body setae distinctly flattened (spatulate), borne on dark pigmented conical chalazae (fig. 3F); integument of body with scattered minute, dark granules (fig. 3F); prothoracic shield extending laterally in front of spiracle to include the prespiracular setal group, (apparently a single seta) (fig. 3G); head entirely black . . . . . *Bocana manifestalis* Walker

[4]In a few specimens the lateral areas of the head capsule are not completely white but exhibit light brown mottling in these areas. However, these specimens lack the definite longitudinal stripes of the head capsule shown by *Anua indiscriminata*.

Body setae not spatulate; prothoracic shield not extended laterally to include prespiracular setae 18

18. Coronal suture very short, less than one-half length of frons, adfrontal sclerites extending to or very nearly to vertex triangle (fig. 3H); skin, particularly dorsal pigmented areas, coarsely or finely granulate *(Agrotis)* 19
Coronal suture longer, greater than one-half length of frons, adfrontals terminating well before vertex triangle; skin not granulate 21

19. Skin beset with relatively large smooth convex granules, diameter of larger granules distinctly greater than that of setal bases (fig. 4A) . . . . . *Agrotis ipsilon* (Hufnagel)
Skin very finely granulate, diameter of largest granules much less than that of setal bases (fig. 4B, 4C) 20

20. Setal pinacula large (most larger than spiracles), strongly pigmented (fig. 4B); setae V, VI, and VII group (ventrad of spiracles) all on well developed pinacula; head with a pair of convergent black stripes laterad of adfrontal sclerites, and a dark spot above each eye cluster . . . . . *Agrotis dislocata* (Walker)
Setal pinacula smaller, most smaller than spiracles (fig. 4C), those of setae ventrad of spiracles unpigmented; head not so marked, lacking dark spot above eye cluster . . . . . *Agrotis crinigera* (Butler)[5]

21. Outer margin of mandible usually serrate, bearing 4 or more distinct teeth (those of fully fed specimens sometimes worn, but normally presence of teeth indicated at least by shallow lobes) 24
Outer margin of mandible not serrate, more or less truncate, or slightly angulate (fig. 4D) 22

22. Outer margin of mandible normally shallowly lobate, if truncate former presence of worn teeth indicated by grooves on outer face; epicranial setae short, p^1 less than one half as long as head capsule . . . . . *Spodoptera exempta* (Walker)[6]
Outer margin of mandible slightly angulate (fig. 4D); epicranial setae longer, p^1 more than 3/4 as long as head capsule 23

23. Eighth abdominal spiracle less than twice as high as seventh (7:5); body marked with diffuse longitudinal pigmented bands, at times interrupted. . . . . *Pseudaletia unipuncta* (Haworth)
Eighth abdominal spiracle twice as high as seventh; body without longitudinal pigmented bands, skin largely pale, except for blackish areas around setal bases . . . . . *Meliana* sp. nr *scotti* (Butler)

24. Inner face of mandible with a distinct retinaculum (figs. 4E, 4I, 4J) 25
Inner face of mandible usually with 2 or 3 curved longitudinal ridges, but without a retinaculum (figs. 5I, 5K) 32

25. One or more setae on inner face of each tarsus near apex distinctly spatulate 26
Apical tarsal setae not spatulate or only slightly so (fig. 4G) 28

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[5]Larvae of *Agrotis evanescens* (Rothschild) from Laysan Island also key out here, and those of some other endemic *Agrotis* spp. are likely to be similar.

[6]This species is keyed out here as well as in couplet 36 because the mandibular teeth in available specimens are poorly developed, and almost completely obliterated in a few.

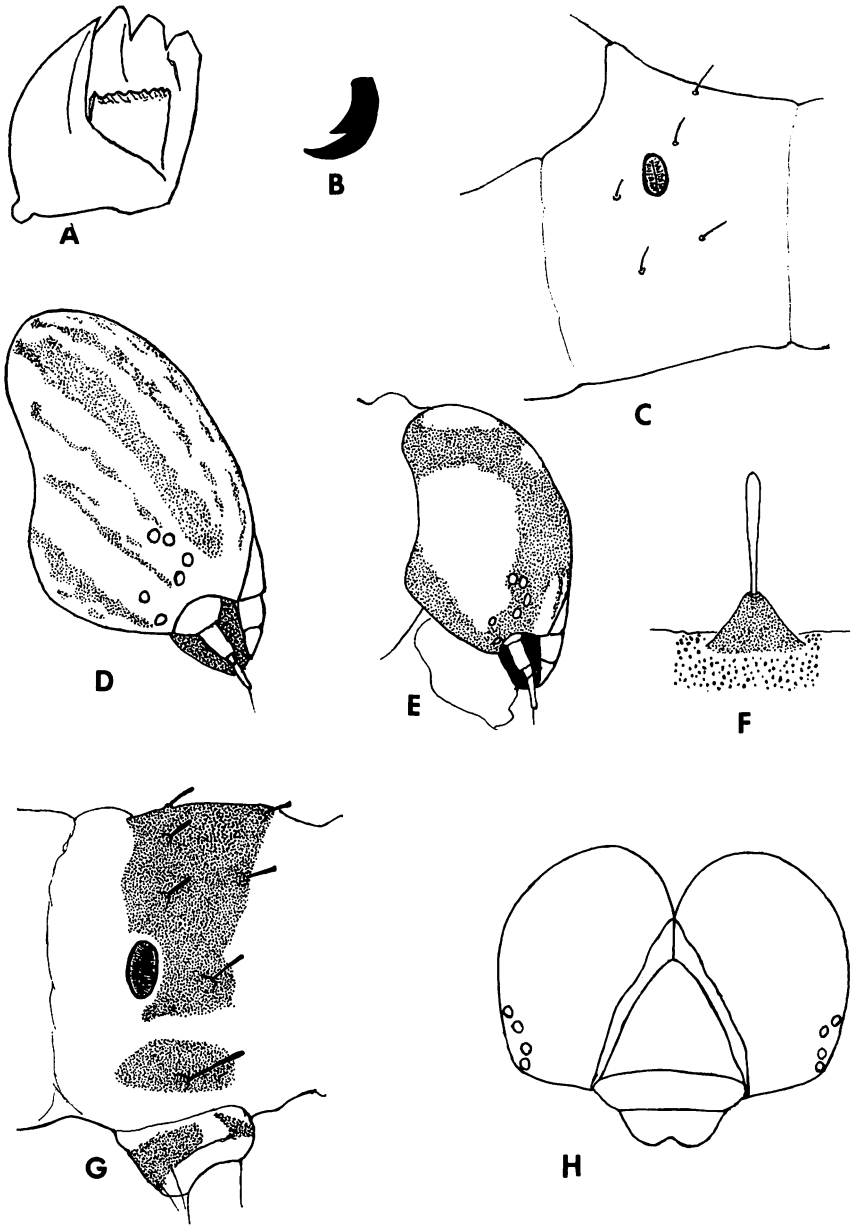

FIGURE 3. A, *Heliothis virescens,* inner face of right mandible; B, *Anomis flavus,* crochet of abdominal proleg; C, *Achaea janata,* eighth abdominal segment to show dorsal gibbosity bearing seta II; D, *Anua indiscriminata,* lateral aspect of head capsule to show markings; E, *Achaea janata,* lateral aspect of head capsule to show marking; F, *Bocana manifestalis,* dorsal abdominal chalaza and surrounding derm to show setal form and dermal granulation; G, *Bocana manifestalis,* lateral aspect of prothorax; H, *Agrotis ipsilon,* outline of head capsule, frontal aspect.

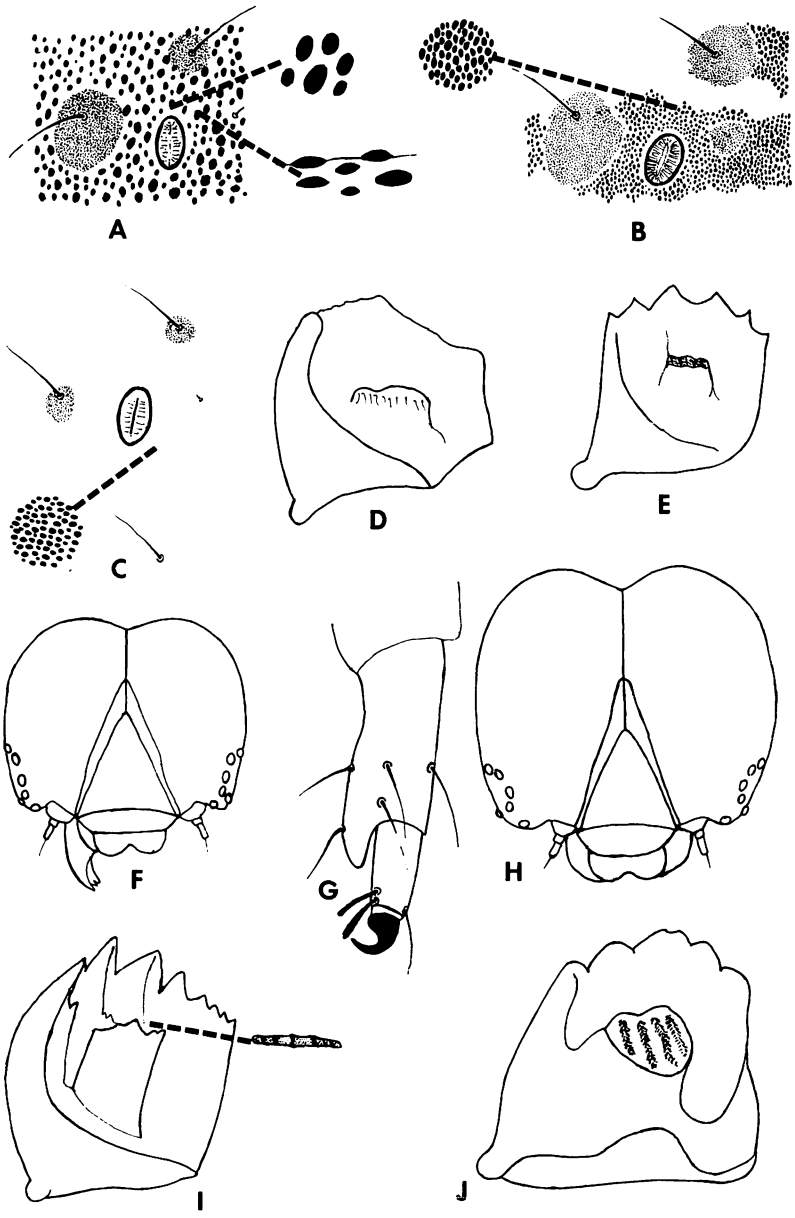

FIGURE 4. A, *Agrotis ipsilon,* fourth abdominal segment to show setal pinacula and dermal granulation; B, *Agrotis dislocata,* fourth abdominal segment; C, *Agrotis crinigera,* fourth abdominal segment (detailed enlargements of dermal granulation in A, B and C all to approximately the same scale); D, *Pseudaletia unipuncta,* inner face of right mandible; E, *Phlegetonia delatrix,* inner face right mandible; F, *Bombotelia jocosatrix,* frontal aspect of head capsule; G, *Ascalapha odorata,* lateral aspect of distal portion of metathoracic leg; H, *Phlegetonia delatrix,* frontal aspect of head capsule; I, *Platysenta illecta,* inner face of right mandible; J, *Ascalapha odorata,* inner face of right mandible.

26. Head capsule largely dark pigmented or with a dark longitudinal stripe on each side; body with dark markings at least above spiracles, and several fine, interrupted subdorsal and dorsal pale stripes; spiracles surrounded by a narrow black ring . . . . . *Hypocala deflorata* (Fabricius)
Head capsule largely pale; body without conspicuous dark markings; spiracles without black outer rings 27

27. Coronal suture relatively short, about as long as frons (fig. 4F); head capsule (in living specimens) with a small, diffuse pigmented area surrounding seta P^1 on each side, similar pigmented areas (usually red in life) normally present around dorsal body setae; on mango . . . . . *Bombotelia jocosatrix* (Guenée)
Coronal suture longer, about 1.5 times as long as frons (fig. 4H); head capsule and body setae without such pigmented areas; on Myrtaceae . . . . . *Phlegetonia delatrix* (Guenée)

28. Retinaculum thin, blade-like, outer edge serrate, outer margin of mandible with 3 large, subequal teeth plus a serrate margin of several much smaller teeth of diminishing size (fig. 4I); head capsule with a board, dark, longitudinal stripe on each side, extending from occipital margin to base of mandible; body largely pale, without dark pigmented stripes; on various herbaceous plants . . . . . *Platysenta illecta* (Walker)
Retinaculum broader, apex truncate with small teeth or ridges on outer face, outer margin of mandible with 4 or 5 distinct teeth but without additional finely serrate section (fig. 4J); head capsule not so marked, body with dark longitudinal pigmented markings; on trees of the family Leguminosae. 29

29. Coronal suture longer than frons (4:3); head capsule with a well-defined broad lateral pale stripe extending from occipital margin to base of circumantennal membrane; adfrontal sclerites and frons (except sometimes at center) pale; inner apex of tibia with a distinct pad-like swelling (fig. 4G); full grown larvae very large, to 4 inches long . . . . . *Ascalapha odorata* (L.)
Coronal suture about as long as, or slightly shorter than frons; head capsule without such a well-defined lateral pale stripe, this region generally brown, sometimes with scattered pale reticulations; adfrontals, and frons at least partially, dark; tibial pads weakly or not at all developed; full grown larvae smaller 30

30. First pair of ventral prolegs distinctly shorter than those following (1/2 to 2/3 as long); suranal plate occupying almost entire tenth tergum, entirely dark, strongly sclerotized, surface strongly wrinkled (fig. 5A); spiracles uniformly black . . . . . *Melipotis indomita* (Walker)
First pair of ventral prolegs only slightly shorter than or about equal to others; suranal plate smaller, only partly covering tenth tergum, partly pale, weakly sclerotized, surface smooth except for a few small pits (figs. 5B, 5C); central disc of spiracles somewhat paler than black rim. 31

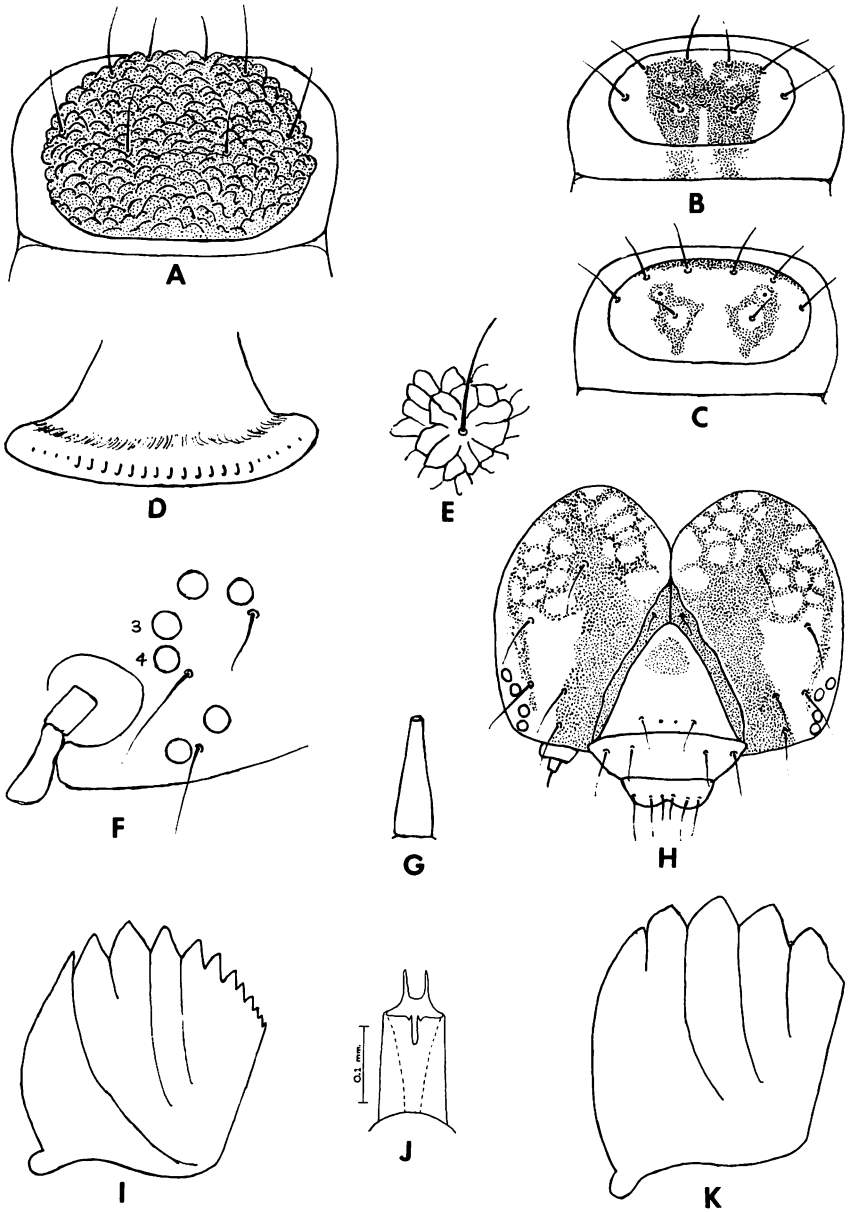

FIGURE 5. A, *Melipotis indomita*, dorsum of tenth abdominal segment to show form of suranal plate; B, *Pandesma anysa*, dorsum of tenth abdominal segment; C, *Polydesma umbricola*, dorsum of tenth abdominal segment; D, *Strictoptera cuculioides*, lateral aspect of ventral proleg; E, *Pandesma anysa*, derm of head capsule surrounding seta P^1 to show raised areolations; F, *Elaphria nucicolora*, anteriolateral portion of head capsule to show relative positions of ocelli; G. *Elaphria nucicolora*, spinneret; H, *Peridroma saucia*, frontal aspect of head capsule; I, *Callopistria* sp., inner face of right mandible; J, *Spodoptera mauritia*, spinneret; K, *Elydna nonagrica*, inner face of right mandible.

31. Suranal plate marked with two distinct dark longitudinal stripes, partly coalesced along midline, pale laterally and along posterior margin (fig. 5B); dorsal regions of head capsule appearing finely wrinkled, the wrinkles defining small, smooth, blister-like areas (areolate) (fig. 5E). . . . . *Pandesma anysa* (Guenée)
Suranal plate weakly marked by light brownish areas on each side and along posterior margin (fig. 5C); head capsule with wrinkling and blisters very weakly developed . . . . . *Polydesma umbricola* Boisduval
32. One or more setae on inner face of tarsus, near apex, distinctly spatulate 33
Tarsi without such distinctly spatulate setae 35
33. Crochets of prolegs reduced in number and size, a row of about 12-16 relatively small hooks on central portion of elongate planta, occupying about one-half to two-thirds of planta length (fig. 5D); body entirely pale, without longitudinal pigmented stripes; on trees of family Guttiferae. . . . . .*Stictoptera cuculioides* Guenée
Crochets not reduced, more than 20 hooks of normal size present, distributed over almost entire length of planta; body usually with longitudinal pigmented stripes 34
34. Mandible with 4 large teeth plus a serrate margin consisting of several (5 to 7) additional smaller teeth of decreasing size (fig. 5I); disc of spiracles distinctly paler than black rims; crochets weakly biordinal at center of row; on ferns. . . . . .*Callopistria* sp.
Mandible with 4 or 5 large teeth, but lacking additional series of small teeth (fig. 5K); disc of spiracles blackish, nearly as dark as rims; crochets not biordinal at center; hosts various . . . . . .*Elydna nonagrica* (Walker)
35. Front of head with a broad longitudinal dark stripe on either side, adfrontal sclerites also dark, but frons largely pale (fig. 5H); body mottled with brownish markings but usually with a relatively large pale area on dorsum of ninth abdominal segment . . . . . .*Peridroma saucia* (Hübner)
Head variously marked, but not as above; ninth abdominal segment without such a large dorsal pale area 36
36. Ocelli 3 and 4 very close together, distance between them equal to not more than 1/3 diameter of 4 (fig. 5F); spinneret relatively narrow, apex acute (fig. 5G); dorsum of abdominal segment two usually with a pair of conspicious, roughly circular, dark spots; size small, full grown larvae about 20 mm long . . . . . .*Elaphria nucicolora* (Guenée)
Ocelli 3 and 4 further apart, distance between them equal to or greater than 1/2 diameter 4; spinneret relatively broad (fig. 5J); without such conspicuous dark spots on dorsum of second abdominal segment; size generally larger, full grown larvae 25-40 mm long 37
37. Central portion of spiracles, inside black rim, very pale . . . . . *Spodoptera exigua* (Hübner)
Central portion of spiracles blackish or brownish, only slightly paler than rims 38

38. Head capsule most strongly pigmented (darkest) in narrow band along outer margin of adfrontal sclerites, frons and adfrontals relatively pale (fig. 1B); dorsum of each body segment normally with a narrow subtriangular black mark on mesal margin of subdorsal pale stripe on each side (figs. 1C, 1D) . . . . . *Spodoptera mauritia* (Boisduval)
Head not so marked, normally without such a dark band but with dark frons and lateral epicranial areas contrasting with pale adfrontals; body with moderately to strongly pigmented striping, but without such subtriangular black marks 39
39. Eighth abdominal spiracles about twice as high as seventh (may be slightly less); on grasses. . . . . *Spodoptera exempta* (Walker)
Eighth abdominal spiracles distinctly less than twice as high as seventh (ca. 10:7); on broadleaf plants . . . . *Spodoptera litura* (Fabricius)[7]

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[7]Within the Hawaiian Archipelago, *S. litura* is known to be established only on the uninhabited islets of French Frigate Shoals. However, it is a common, widespread pest species which is likely to appear on the main Hawaiian Islands at sometime in the future.